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Pilot Information Center for Preflight Planning

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Final Report

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800 Independence Ave., S.W.
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January 15, 1994

Dear Colleague:

For some time, the Federal Aviation Administration (FAA) has been concerned about the number of general aviation (GA) accidents resulting from inadequate preflight preparation. Recently, we contracted for several studies on a concept called Pilot Information Center (PIC). We also developed a prototype PIC model and demonstrated it to the GA community. While those efforts were well received, there is not a universal consensus that PIC should be implemented.

In an era of fiscal constraints, the FAA must continually look for ways to provide better services at less cost. As a part of this reexamination, we ask the aviation community for advice.

> What is the best way to provide the preflight services needed by GA?
>
> What is the best way to encourage a greater percentage of pilots to do adequate preflight planning?
>
> What services are needed?
>
> Who should provide them?
>
> How do we pay for them?

In concert with the GA community, the FAA has initiated several efforts to address these issues. It is not our intent to offer PIC as the answer to all of these questions. Rather, we offer this report in the interest of information sharing, particularly on the issue of what services are required.

Looking back over the last dozen years, we see tremendous growth in the quantity and quality of information available for preflight preparation and the number of sources from which such information can be obtained. As we continue grappling with how to provide better services at lower costs, let us not lose sight of the need to do this in a way that contributes to safer operations.

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16. Abstract

Based on accident analysis and literature review, this effort developed a list of the types of information that pilots need for preflight planning. This report also discusses the Pilot Information Center, a potential method for distributing this information.

This report is one of two being published on PIC. The other report is DOT/FAA/SP-93/2, Performance Guidelines for Pilot Information Centers. Both documents address the issue of what services are required for GA preflight planning.

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1.0 INTRODUCTION

1.1 BACKGROUND

General Aviation (GA) accident briefs have highlighted the need to determine how flight safety can be improved to prevent and to reduce the severity of such accidents. Overwhelmingly, investigators of these accidents point to human and other non-mechanical error as major causal factors. Further analysis of these accidents reveals that preflight planning is often incomplete, improper or ignored altogether. This encourages poor decisions towards preflight and en route flight operations.

Preflight planning provides a foundation from which decisions are made about a flight. It is required by Federal Air Regulation (FAR) 91.5. Specifically, the regulation states:

> *"Each pilot in command shall, before beginning a flight, familiarize himself with all available information concerning that flight...."* The law goes on to say that this will include weather reports, forecasts, fuel requirements, alternatives available if the planned flight cannot be completed, and any known traffic delays of which the pilot has been advised by air traffic personnel.
>
> The pilot may also be required to obtain..."runway lengths...takeoff and landing distance...flight manual, other reliable information appropriate to the aircraft, relating to aircraft performance under expected values of airport elevation and runway slope, aircraft gross weight, and wind and temperature."

Very simply, the "flight" starts on the ground. Within the context of this first step, the interpretation of all pertinent data regarding the flight must be fully understood or within reach to expand the pilot's awareness of the flight conditions. However, regulations change or are often forgotten, infrequent fliers loose their ability to appropriately interpret weather conditions and the increasing complexity of airspace requirements may exceed his/her knowledge.

If the information were available during preflight preparation in a visual and easily comprehensible format, a pilot's knowledge could be refreshed prior to the flight rather than jumping into an adverse environment or condition such as poor visibility or a misjudged crosswind.

This project looked at the system deficiencies (e.g. accidents, information, programs) in order to identify the solutions to the problem facing pilots today. The effort included not only research into the accident data bases and literature but originally sought input from the user community to help define these deficiencies and solutions.

1.2 OBJECTIVES

The purpose of this project was to assist the FAA in determining the types of information which should be provided to pilots to help them improve the preflight planning process. In addition, a means of disseminating the information was to be conceptualized for future specification. Specifically, the objectives of this research effort included the following:

- Analyze the accident data and literature to identify common denominators in accidents that are related to poor preflight planning.
- Determine what deficiencies exist in the current weather data acquisition system from a pilot's perspective.
- Analyze existing commercial weather and preflight planning services.
- Identify a "plain English" format that will make it easy to interpret the weather information and determine what additional flight planning information would be necessary to enhance the pilot's familiarity with the route, ATC procedures, and the aircraft.

1.3 PROJECT TASKS

The objectives described above were achieved through the performance of the following tasks:

A. Conduct a literature Search and Review Existing Accident/Incident Data Base: Task includes informal inquiry into NASAO preflight planning services nationwide and a review of the FAA weather service program plans for the future.

B. Conduct Regional Listening Sessions: Four regional listening sessions were to be held in conjunction with air shows and "Super Seminars", the first being the EAA Air Show at Oshkosh, Wisconsin. Questions regarding system deficiencies were to be asked of the pilot audience to determine what improvements were necessary to improve pilot's preflight planning techniques.

C. Develop Guidelines for PIC: Review of the information obtained via tasks 1 and 2 in order to prepare a list of problems currently existing in today's operating environment and determine candidate solutions to these problems.

1.4 SCOPE

The following is an overview of the tasks identified to accomplish these objectives:

Table 1.0 Task Schedule

TASK NO.	TASK DETAIL	SCHEDULE IN MONTHS 0 1 2 3 4 5 6 7 8 9
1.	Literature/Data Search	---- △
2.	Listening Sessions	----------------△
3.	Analysis/ Recommendations	--------------•------•-----------△
4.	Documentation:	
	a. Meetings	•----------•--------------•------------△
	b. Briefings	•------•
	c. Interim Report(s)	------•----------△
	d. Final Report	--------------△

Legend: • - interim milestone
△ - milestone or summary milestone

2.0 METHODOLOGY AND DISCUSSION

This section covers the project tasks, their content and how they were accomplished so that a clearer understanding of the results can be obtained. It is important to note that the focus of this project changed slightly for reasons enumerated in the subsections on the methodology.

2.1 LITERATURE SEARCH/DATA ACQUISITION

2.1.1 Literature Search:

A literature search was conducted as one of the first tasks of the project through the services of Florida Atlantic University's "DIALOG Search." A total of ten data bases were investigated using a search strategy combining the key words of: General Aviation, Accident, Weather, Safety, Preflight Planning, Preflight, Planning. Additionally, search streams of combinations of these key words were used to narrow the fields of data and make the search more accurate.

The Aircraft Owners and Pilot's Association was also asked to search their Magazine digest to identify relevant articles and books which focused on preflight planning and safety. At the time of this literature search, the AOPA Magazine archives are not automated and results of their search were unsatisfactory. Only five articles were received. These have been annotated in the list below.

PERIODICALS - SOURCES:

Trade and Industry ASAP: Produced by Information Access Company, provides complete indexing for more than 90 trade-specific and general business publications, news releases and wire stories.

Magazine ASAP: Produced by Information Access Company (IAC) providing indexing of more than 100 frequently cited American magazines.

National Newspaper Index: Produced by Information Access Company (IAC) provides indexing of "The Christian Science Monitor", "The Los Angeles Times", "The New York Times", "Wall Street Journal" and "The Washington Post" and wire services of PR NEWSWIRE and REUTERS FINANCIAL REPORT.

McGraw-Hill News: Full text of publications owned and published by McGraw-Hill, Inc. (Aviation Week & Space Technology).

American Statistics Index: Comprehensive index of statistical publications from more than 400 central or regional issuing agencies of the U.S. Government. Provides abstracts and indexing of all federal statistical publications including non-GPO publications.

AOPA PILOT: Produced by the Aircraft Owner's and Pilots Association for its membership and interested parties.

TECHNICAL REPORTS - SOURCES:

Compendex Plus, 1970-1989: Database of significant engineering and technological literature produced by Engineering Information, Inc. and corresponds to the printed publication "Engineering Index."

National Technical Information Service, 1964-1989: NTIS is the central source for public dissemination of U.S. government sponsored research and consists of unclassified government-sponsored research, development and engineering reports.

Aerospace Database, 1962-1989: Online version of two printed publications: International Aerospace Abstracts (IAA) and Scientific and Technical Aerospace Reports (STAR).

Transportation Research Information Service, 1970-1989: a composite file produced by the Transportation Research Board, of either abstracts of published articles and reports, or summaries of ongoing planning, development, operations, and performance of transportation systems and their components. Includes international coverage of ongoing research projects, published journal articles, state and federal government reports, conference proceedings research and technical papers.

McGraw-Hill Publications Online, 1985-1989: Full text of publications owned and published by McGraw-Hill, Inc.(Aviation Week & Space Technology).

RESULTS OF LITERATURE SEARCH:

The following are documents that are judged to be most relevant to the subject area:

"Passenger Briefings," Article on providing preflight briefing to passengers so that in the event an emergency should occur, the pilot's attention is not diverted from operating the aircraft. Highlights do's and don't's in and around the aircraft. Golbey, S.B., AOPA Magazine, November 1989.

"The Preflight Ground Game: Survival Strategies," Analysis of preflight game given to group of pilots to determine the level and depth of the preflight planning activity conducted by the participants. Cessna 172 was "rigged" with 11 problems. None of the 14 test pilots identified all 11 problems. Mathews, C.J., AOPA Magazine, November 1983.

"Preflight: The Last Chance," Discussion of how thorough preflight planning and inspections can prevent life threatening and embarrassing mistakes resulting from preflight inspection contest held by the National Intercollegiate Flying Association, Horne, T.A., AOPA Pilot, May, 1989.

"Preflight Action and Safety Belts and Shoulder Harnesses," Review of the FAA regulations regarding safety belts and shoulder harnesses that would govern a typical general aviation non-commercial flight, Yodice, J.S., AOPA Pilot, July, 1987.

"The Instrument Flight Rules: Takeoff and Landing," Review of the FAA regulations 91.116 governing IFR approaches and departures for personal and business operators, Yodice, J.S., AOPA Pilot, May 1989.

"VMC to IMC," Visual meteorological conditions to instrument meteorological conditions; statistical report on weather-related aircraft accidents, Aarons, Richard N. Business & Commercial Aviation, Vol. 64.

"Accident review, 1985," Review of NTSB reports, Olcott, John W., Business & Commercial Aviation, Vol. 62, pg 100(1), March 1988.

"Maintenance and Air Safety," Discussion of private flying safety measures as they pertain to general aviation, rules and regulations, maintenance and repair, Parrish, R.L., Business & Commercial Aviation, Vol. 62, pg 94(5), June 1988.

"Safety Statistics for the Prudent Pilot," Review of accident rates and statistics including pilot time, time in type, age and accident degree of injury for all 1983 accidents, Aarons, R.N., Business & Commercial Aviation, Vol. 61, pg 54(4), July 1987.

"Fundamentals Always Count," Discussion of safety measures including maintenance, pilot proficiency and prudence, Olcott, J.W., Business & Commercial Aviation, Vol.. 57, pg 178(1), September 1985.

"A regulatory change for the better," Report on the new NTSB accident reporting requirements and relationship to air safety, interpretation in accident law and reconstruction, Wolk, A.A., Business & Commercial Aviation, Vol. 57, pg 172(2), September 1985.

"Selling safety: to err is human - and cripplingly expensive," (Editorial), Collins, R. L., Flying, Vol 112, pg 24(1), October 1985.

"Bottle & throttle; two flying editors drink up before taking off in SimuFlite's Lear 55 simulator, all in the name of science," Collins, R.L., McClellan, J. Mac, Hopkins, J., Flying, Vol. 12, pg 72(5), August 1985.

"Trouble with twins; two engines don't guarantee safety. (standards for flying twin-engined light planes)," (editorial), Collins, R.L., Flying, Vol. 112, pg 20(1), February 1985.

"Roots; looking beyond pilot error," (editorial), McClellan, J. Mac, Flying, Vol. 112, pg 20(1), January 1985.

"Airplanes don't crash...pilots do; in case after case, pilots attempt to fly beyond their skill level and come up short," Collins, Richard L., Flying, Vol. 111, pg 85(3), July 1984.

"Pilots, alcohol and airplanes," McClellan, J. Mac, Flying, Vol. 110, pg 90(4), December 1983

"Running the risks," Collins, R.L., flying, Vol. 110, pg 72(3), April 1983.

"Safety Board Reports Says U.S. Air Accidents Down in 1988 (But Pan Am crash sends annual death toll well above 1987 level," Article focusing on NTSB figures showing the rates and total number of accidents dropped significantly from 1987...with record lows for general domestic aviation, McGraw-Hill News, May 1989

"F-117A Crash Reports Cite Pilot Fatigue, Disorientation," Scott, W.B., Aviation Week & Space Technology, Vol. 130, No. 19, pg 22, May 15, 1989.

"Transport Canada Gander Crash Review Focuses on Safety Issues, Not Causes," Aviation Week & Space Technology, Vol 130, No. 11, pg 66, March 13, 1988

"Sweden's First Gripen Prototype Destroyed in Crash on Landing," Prototype Gripen crashes during landing at a public flight display at Saab-Scania's Linkoping facility. It was the pilot's first flight in the Swedish multi-role combat aircraft, Aviation Week & Space Technology, Vol. 130, No. 6, pg 25, February 6, 1989.

"FAA Credits Improved Safety Record to Training, Equipment," Aviation Week & space Technology, Vol. 129, No. 7, pg 123, August 15, 1988.

"Board Examines Radar's Role In Cerritos Midair Collision," Aviation Week & Space Technology, Vol. 127, No. 24, pg 127, December 14, 1987.

"NTSB Analyzes Factors Leading to California Midair Collision of DC-9, Piper Aircraft" Aviation Week & Space Technology, Vol. 127, No. 22, pg 59, November 30, 1987.

"Aeromexico Midair Hearing Highlights ATC Limitations," NTSB investigation report of the midair collision between the Aeromexico DC-9 and Piper Archer placed the aircraft in the above positions at the time of the accident...., Mordoff, K. F., Aviation Week & Space Technology, Vol. 125, No. 23, pg 29, December 8, 1986.

"Weather Briefing Use and Fatal Weather Accidents," Examination of quantitative reduction in risk associated with use of a weather briefing. Fatal weather accidents between 1964 and 1981 show that pilots had lower incidence of use of weather briefings than the pilot population overall. Golaszewski, R., Gellman Research Associations for Transportation Research Board, N1158, pg 21-28, Fig. 12, Tab 10, 1988.

"General Aviation Pilot Error: A Study of Pilot Strategies in Computer Simulated Adverse Weather Scenarios," Researchers contrived various routes and weather scenarios to determine the relationship between preflight planning and accident rate. Included analysis of hazard based on pilot ratings, time and age in preflight decision making. Rockwell, T.H., McCoy, C. E. Ohio State University for Transportation Systems Center, DTRS-57-85-C-00101, March 1988.

"Insurance Companies Spur Increase in Pilot Training," Proctor, Paul, Aviation Week & Space Technology, Vol. 126, No. 18, pg 82, May 4, 1987.

"Aviation Weather: Status of FAA's New Hazardous Weather Detection and Dissemination Systems," A summary of the FAA's efforts to develop better ground based hazardous weather detection systems and disseminate the information to pilots in a more timely manner. General Accounting Office, GAO/RCED-87-208; B222882, September 1987.

"U.S. General Aviation Takeoff Accidents: The Role of Preflight Preparation," General aviation accidents at takeoff, number and severity by detailed cause and type of pilot, and description of hazards to consider in preflight planning, NTSB, March 1976.

"A Summary and Integration of Research Concerning Single Pilot IFR Operational Problems," A review of seven research studies pertaining to Single Pilot IFR (SPIFR) operations identifying key issues and problems in SPIFR, Chapman, G. C., Ohio State University, AIAA, October 1983.

"General Aviation Safety - How Safe? Its Implication for Flying and Theory Training," The three dominant accident causes are related to continued flight into deteriorating weather, takeoff and landing away from airports, and illegal low flying. Attention is given to the types of occurring accidents, approaches for minimizing the risk without loss of freedom or prohibitive cost, problems related to poor public relations, the relevance of difficult examinations, safety problems, the causes of fatal accidents, and the value of ground instruction. Cooper, W.G., International Journal of Aviation Safety (ISSN 0264-6803), Vol. 1, pg 23-29, June 1983.

"Aviation Weather," Accurate detection of weather around an airport and the most effective means of transmitting that information to a pilot are discussed. Proceedings from hearing before the Subcommittee on Investigation and Oversight and the Subcommittee on Transportation, Aviation, 2nd Session of the 97th Congress, General Publications Office, August 1982.

"Mesoscale Convective Complexes and General Aviation," Weather continues to be a causative factor in approximately 40% of the fatal accidents involving general aviation. This investigation involves the impacts of Mesoscale Convective Complexes (MCCs) upon general aviation operations. Structure, evolution and life-cycle of these convective weather systems are contrasted with 'idealized' conceptions of thunderstorm activity over the U.S., e.g. the frontal or prefrontal squall line and the 'air mass' storms. MCC is the third type of thunderstorm weather system. Maddox, R.A., Fritsch, J.M., NOAA Environmental Research Laboratories, Proceedings from the International Conference on Aviation Weather System, pg 209-214, May 1982.

"Aircraft accident reports. Brief Format, U.S. Civil Aviation: Issue No. 11, 1979 Accidents," Selected aircraft accidents reports in brief format occurring in U.S. civil aviation operations during calendar year 1979 are described. Compilation of facts, conditions, circumstances and probable causes for accidents in brief format. NTSB, NTSB-BA-80-8, October 1980.

"Briefs Of The Fatal Accidents Involving Weather As A Cause/Factor, U.S. General Aviation, 1978," Compilation of facts, conditions, circumstances and probable causes for each of 322 fatal accidents in brief format. Additional statistical information was tabulated for all accidents involving weather as a cause/factor by types of accident, phase of operation, injury index, aircraft damage, pilot's certificate, injuries and cause/factor(s), NTSB, NTSB-AMM-80-5, Bureau of Technology, August 1980.

"Briefs of Fatal Accidents Involving Weather as A Cause/factor, U.S. General Aviation, 1977," Compilation of facts, conditions, circumstances and probable causes for each of 258 fatal accidents in brief format. Additional statistical information was tabulated for all accidents involving weather as a cause/factor by types of accident, phase of operation, injury index, aircraft damage, pilot's certificate, injuries and cause/factor(s), NTSB, NTSB-AMM-78-16, Bureau of Technology, December 1978.

"Briefs of Fatal Accidents Involving Weather as A Cause/factor, U.S. General Aviation, 1976," Compilation of facts, conditions, circumstances and probable causes for each of 262 fatal accidents in brief format. Additional statistical information was tabulated for all accidents involving weather as a cause/factor by types of accident, phase of operation, injury index, aircraft damage, pilot's certificate, injuries and cause/factor(s), NTSB, Bureau of Technology, NTSB-AMM-78-5, April 1978.

"Annual Air Law Symposium, 12th Dallas, Texas, Compilation of Papers," Papers presented on various developments in aviation case law with particular attention to liability in aircraft accident for flights occurring during IFR operations. Topics include...availability and use of weather data. Liability, under IFR flight conditions, of the government, the pilot, the airframe and component manufacturer and the chart maker is examined. Journal of Air Law and Commerce, Vol. 44, No. 2, 1978.

"Spatial Disorientation in General Aviation Accidents," A review of six year period of accident reports from NTSB was conducted. Spatial Disorientation (SD) rated as the third highest 'cause' in fatal small fixed wing aircraft accidents and is closely related to the second highest cause - continued VFR flight into adverse weather. Non-instrument rated pilots were involved in 84.47 percent of SD accidents. Kirkham, W.R., Collins, W.E., Grape, P.M., Simpson, J.M., Wallace, T.F., Civil Aeromedical Institute, FAA-AM-78-13, March 1978.

"Summary Report of the General Aviation Committee," Committee inputs to the conference regarding fatal weather involved, general aviation(GA) accidents and weather observations at GA airports. Findings: Pilots are not aware of the meteorological services and publications available, meteorologists do not seem to have sufficient understanding of GA requirements. There is a wealth of weather data available within the DOD not available in the civil system. Goodrich, W.C., Aircraft Owners and Pilots Association, Proceedings from the 1st Annual Meteorological and Environmental Conference, March 1977.

"A Synopsis of the Weather Problems Facing Today's General Aviation (GA) Pilots", PIREPs have been difficult to obtain and disseminate. Cooperative efforts on the application of technology to the acquisition and dissemination of en route weather data for those pilots in the air as well as those who are flight planning on the ground. A comprehensive 3-D computer storage system is proposed that receives weather information from all aircraft on IFR flight plans and stores this information by altitude and geographic coordinates. Pope, J.C., FAA at the 1st Annual Conference on Meteorology and Environment, March 1977.

"Pilot Error: Anatomies of Aircraft Accidents," 25 Accident reports were reviewed and found that: most of the accidents occurred when instrument flight rules were in effect, causes of the accidents/incidents included icing, failure to take into account destination weather conditions, incorrect positions, premature descent and pilot panic. Book; et al., Van Nostrand Reinhold Co., 1977.

"Briefs of Fatal Accidents Involving Weather as A Cause/Factor, US General Aviation 1975," Compilation of facts, conditions, circumstances and probable causes for each of 283 fatal accidents in brief format. Additional statistical information was tabulated for all accidents involving weather as a cause/factor by types of accident, phase of operation, injury index, aircraft damage, pilot's certificate, injuries and cause/factor(s), NTSB, Bureau of Technology, NTSB-AMM-77-5, 1975.

"The Safe Airline," Safety practices and experiences for airlines, aircraft, airports and pertinent agencies,...weather hazards, safety philosophy...human factors...are discussed. Procedures for measuring air safety and... practices followed by some airlines are also covered. Ramsden, J.M., MacDonald and Jane's Publishers, 1976.

"Briefs of Fatal Accidents Involving Weather as A Cause/Factor, US General Aviation 1974," Compilation of facts, conditions, circumstances and probable causes for each of fatal accidents occurring in 1974 presented in brief format. Additional statistical information was tabulated for all accidents involving weather as a cause/factor by types of accident, phase of operation, injury index, aircraft damage, pilot's certificate, injuries and cause/factor(s), NTSB, Bureau of Technology, NTSB-AMM-77-5, 1975.

"Special Study of Fatal Weather-Involved, General Aviation Accidents-1964-1972," Examination of details and circumstances surrounding accidents over nine year period. Cause/factors analyzed included weather phenomena, accuracy of weather forecasts, source and adequacy of briefings, time of day, type of flight plan and time of year. NTSB, Bureau of Aviation Safety, NTSB-AAS-74-2, August 1974.

"Study of Preflight Procedures of General Aviation, Final Report," Analysis of relationships between accidents and preflight procedures in general aviation, Patterson, D.G., Wiggins, J.R., Stanwick Corporation for the FAA, FAA-DS-70-10, April 1970.

"Engineering and Development Program Plan - Weather," Description of the FAA R&D activities relating to aviation weather including: providing tailored weather information for use by pilots and ATC, weather data acquisition, weather data processing and distribution, FAA, Office of Systems Engineering Management, FAA-ED-15-1, February 1973.

"Review of Rotorcraft Accidents, 1977-1979," Review of 890 rotorcraft accidents that occurred from 1977-1979. NTSB, Bureau of Technology.

"NonFatal Weather - Involved General Aviation Accidents, Special Study 1964-1974," Eleven year study period finding that inadequate preflight planning preparation and/or planning was the most frequently cited cause in which both pilots and weather were involved. Most of the nonfatal, weather involved general aviation accidents occurred during the landing regime under unfavorable wind conditions. Other major factor was low ceilings. National Highway Safety Administration, 1976.

"Single Pilot IFR Operating Problems Determined from Accidental Data Analysis," Examination of accidents occurring under IFR weather. Problem areas found include: ..., pilot weather briefings, ... fuel mismanagement, pilot overconfidence. Recommended areas of research included: ...more effective pilot training and experience acquisition methods, and better weather data dissemination techniques. Forsyth, D.L., Shaughnessy, J.D., Langley Research Center, National Aeronautics and Space Administration, NASA-TM-78733, September 1978.

"Flying Safely," Exploration of accident causes and promotion of an understanding of the factors that affect the general safety record. Topics include: VFR weather related accidents; IFR weather-related accidents, night flying, ... alcohol and illegal drugs., Collins, R. L., Delacorte Press.

"Comments on the Problem of Turbulence In Aviation," Discussion of the problems and impacts of turbulence on aviation safety. Includes an analysis of weather involved accidents from 1982-1984. Turbulent situations such as strong low-level winds across rough terrain, convective turbulence due to solar heating and instability are highlighted Other causal factors are reviewed such as those attributable to pilot actions or maintenance problems. McLean, J.C., NTSB, at the Conference on Atmospheric Turbulence Relative to Aviation, Missile and Space Programs, April 1986.

"Corporate Aviation Safety Seminar: Advancing Safety Through Effective Communication," Sixteen (16) papers presented on communication attitudes, effective communication, management role, pilot performance, radar interpretation, weather developments. Anon, Flight Safety Foundation Inc. Conference on Aviation Safety, April 1984.

"Summary and Integration of Research Concerning Single Pilot IFR Operational Problems," NASA research for development of technology to improve safety and utility of general aviation (GA) single pilot instrument flight rules operations, Chapman, G. C., Ohio State University for NASA, August 1983.

"Statistical Analysis of General Aviation Stall Spin Accidents," Summary and analysis of four accident types between the years 1965 and 1973., Silver, B.W., aircraft safety consultant, Society of Automotive Engineers, April 1976.

"Aviation Weather: Status of FAA's New Hazardous Weather Detection and Dissemination Systems," Summary of FAA efforts to develop better ground-based hazardous weather detection systems and disseminate the information to pilots in a more timely manner. General Accounting Office, GAO/RCED-870-208, September 1987.

"Aircraft Accident Report-Piper PA-23-150, N2185P and Pan American World Airways Boeing 727-235, N4743, Tampa, Florida, November 6, 1986," Determination of probable cause of accident was the decision of the pilot of the Apache (PA-23-150) to continue a precision instrument approach below the published decision height when the require visual references were not distinctly visible and identifiable. Contributing to the accident was the pilot's failure to obtain a predeparture weather briefing before choosing a means to travel to his destination. NTSB, NTSB/AAR-87/06, June 1987.

"Aircraft Accident Report: Midair Collision of Wings West Airlines Beech C-99 (N6399U) and Aesthetic, Inc., Rockwell Commander 112TC N112SM near San Luis Obispo, California, August 24, 1984," Analysis of accident and determination that the probable cause of the accident was the failure of the pilots to follow the recommended communications and traffic advisory practices for uncontrolled airports contained in the Airman's Information Manual. NTSB, Bureau of Accident Investigation, August 1985.

"Proceedings of the 6th Workshop on Meteorological and Environmental Inputs to Aviation Systems," Workshop objectives are to satisfy such needs as the expansion of our understanding and knowledge of the interaction of the atmosphere with aviation systems, the better definition and implementation of services to operators with aviation systems, the better definition and implementation of services to operators, and the collection and interpretation of data for establishing operational criteria. Frost, W., Camp, D.W., University of Tennessee Space Institute, October 1982.

"Aircraft Accident Report - Coin Acceptors, Inc., Cessna Model 551, Citation II, N2CA, Mountain View, Missouri, November 18, 1982." NTSB determined that the probable cause of the accident was the loss of control of the airplane following the takeoff in instrument meteorological conditions as a result of the pilots use of attitude/heading instruments which had not be come operationally usable and/or his partial reliance on the copilot's flight instruments which resulted in an abnormal instrument scan pattern leading to the pilot's disorientation. Contributing to the accident was the pilot's hurried and inadequate preflight procedures.

"Aircraft Accident Report - Texasgulf Aviation, Inc. Lockheed Jetstar N520S Near Westchester County Airport, White Plains, New York, February 11, 1981," NTSB determined that the probable cause of this accident was a distraction to the pilot at a

critical time as a result of a major electrical system malfunction and during adverse weather. The aircraft had recently undergone a modification which lead to a series of multiple generator failures prior to the accident.

"Special investigation Report - Flight Service Station Weather Briefing Inadequacies," Investigation of 72 aviation accidents which lead to NTSB determination that pertinent meteorological information was not passed to the pilot during the weather briefing provided by Flight Service Station personnel, in spite of the fact that this information was required by FSS handbook, 7110.10. The Safety Board determined that failure to pass the information was a factor in 5 of the 6 accidents, the remaining accidents revealed deficiencies in the weather briefing were serious enough to warrant discussion. NTSB, Bureau of Technology, August 1981.

"Aircraft Accident Report - Rocky Mountain Airways, Inc., DeHavilland DHC-6 Twin Otter N25RM Near Steamboat Springs, Colorado, December 4, 1978," NTSB determined that the accident was due to severe icing and strong down drafts associated with a mountain wave which combined to exceed the aircraft's capability to maintain flight. Contributing to the accident was the captain's decision to fly into probable icing conditions that exceeded the conditions authorized by company. NTSB, Bureau of Accident of Investigation, NTSB-AAR-79-6, May 1979.

"Flight Plan Use and Safety Performance," A study designed to identify whether a relationship exists between flight plan filing and general aviation safety performance. A secondary objective of the study is to demonstrate the utility of methodologies to assess the benefits of FAA safety initiatives. Golaszewski, R., Gellman Research Associates, Inc. under subcontract to Statistica, Inc. for Transportation Systems Center, August 1986.

"Aircraft Accident Report-Pilgrim Aviation and Airlines, Inc., DeHavilland Turbo Prop DHC-6 N124PM, in Long Island Sound Near Waterford, Connecticut, February 10, 1970," The Dehavilland Twin Otter ditched while on an instrument flight plan 2 hours and 16 minutes after departing from Trumbull Airport, Connecticut on a round trip cross country to JFK International Airport. The NTSB determined that the accident was due to fuel exhaustion resulting from inadequate flight preparation and erroneous in-flight decisions by the Pilot-in Command. NTSB, NTSB-AAR-71-1, January 1971.

"General Aviation Pilot Education Program (GAPE)," A safety program designed to improve the aeronautical education of the general aviation pilot in anticipation that the national aircraft accident rate might be improved. GAPE attempted to reach out to the average GA pilot with specific and factual information regarding the pitfalls of contemporaries involved in aviation accidents and what could be done to avoid them. Cole, W. L., Flight Safety Foundation, Inc., for the FAA, FAA-FS-67-1, September 1967

2.1.2 NTSB Data:

Task 1 included an analysis of the accident data related to improper preflight planning obtained through NTSB. The rationale for reviewing accident briefs and statistics was to extract a list of the most frequent cause/factors of these accidents to determine what types of information the Pilot Information Center (PIC) might provide to stem their incidence. Identifying the problems would lay the foundation for the "encyclopedia" of services, tutorials and general pilot information pertinent to the go/no-go decision making process.

Three sets of technical material were obtained: NTSB tabulations of preflight planning accidents for the years 1972-1986; NTSB short briefs on accidents due to inadequate preflight planning; and technical reports - Weather Briefing Use and Fatal Weather Accidents[1], General Aviation IFR Operational Problems[2], and A Study of Pilot Strategies in Computer Simulated Adverse Weather Scenarios[3].

These data resources provided the following types of information critical to establishing an outline of services for the PIC:

> NTSB Accident Statistics - Statistics of accidents directly related to inadequate preflight planning.
>
> NTSB Accident Briefs - Summaries of pertinent information and testimony regarding accidents where inadequate preflight planning was a cause and/or factor of the mishap.
>
> Technical Reports - In depth analyses of preflight planning activities, retrieval of weather information and related accidents.

The NTSB tabulations of accident data for the years 1978 through 1986 showed accidents declining overall during the nine year time frame. However, there has been a general increase in the percentage of accidents related to planning/decision making generally

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[1] "Weather Briefing Use and Fatal Weather Accidents", Golaszewski, R., Gellman Research Associates, Publication No. 1158, Aviation Papers Transportation Research Board of the National Research Council, 1988.

[2] "General Aviation IFR Operational Problems", Bolz, E.H., Eisele, J.E., Systems Control Technology, NASA Contractor Report 159022, Contract No. NAS115313, April 1979.

[3] "General Aviation Pilot Error, A Study of Pilot Strategies in Computer Simulated Adverse Weather Scenarios", Rockwell, T.H., McCoy, C.E., Ohio State University for Transportation Systems Center, Contract No. DTRS-57-85-C-00101, March 1988.

and to inadequate preflight planning, specifically. Between 1982 and 1986, 70% of the cause/factors of accidents could be attributed to improper preflight planning. These span a variety of preflight and in-flight judgement problems including:

Preflight preparation	Aircraft preflight
NOTAMs	Inflight decisions
Flight into known adverse weather	VFR flight into IFR conditions
Improper weather evaluation	Initial fuel and refuel miscalculations
Performance data	Wind compensation
Procedures: IFR and VFR	Checklist improper or not accessible
Judgment	
Unfamiliarity with communications information	

As evidenced above, pilots often forget that preflight planning involves more than just tracing the route of intended flight and calling flight service. Therefore, it is possible that many other accidents or incidents may have their root in poor preparation. For example, the pilot who does not understand terminal area communications procedures and frequencies has not adequately reviewed the charts and listed the pertinent information needed for operations in controlled airspace. Obtaining the information before leaving not only helps organize the pilot mentally but prevents cockpit distractions such as opening charts and looking for details. These distractions can lead to another major cause of planning related accidents (8-12% between 1982-86), visual outlook.

Other common denominators in many of these areas include: failure to obtain or understand preflight weather information; ignoring weather briefings, hazardous weather or weather forecasts, failure to update weather information or NOTAMs; poor understanding of skill requirements for operational challenges, e.g. high density altitude, crosswind handling, emergency procedures, etc. As an example, the scenario summarized below is typical of many accidents where the pilot did not obtain the information fundamental to his flight.

WHAT HAPPENED: The student pilot obtained a weather briefing from Fort Worth FSS and filed a VFR Flight plan for cross-country flight from Plainview, Texas to Roswell, New Mexico via Hobbs, New, Mexico. The pilot landed at Roswell, refueled and filed a return VFR flight plan without obtaining an updated weather briefing. A cold front had passed through the area bringing a wind shift and high gusty winds. The pilot was cleared for takeoff on Runway 30 and was told winds were 310 degrees at 29 kts. As the pilot released the brakes, the control tower told the pilot that the winds were 310 degrees at 39 knots. Wind gusts raised the right wing and the aircraft was blown over.

WHAT WENT WRONG: This accident points to several problems that should have been obvious before the pilot tried to leave Roswell.

Wind conditions - The crosswind component and gusts may have exceeded not only the airplane's flight envelope but also the limits of the pilot's capabilities.

Preflight briefing not obtained - Had the pilot in command obtained the weather briefing during his call to FSS, he might have understood the implications of a passing cold front on wind speed. He might also have referred to the owners flight manual to determine if the crosswind component exceeded that of the safe operating envelope of the aircraft.

Lack of experience in type of operation (crosswind) - The pilot in command could not adequately compensate for the strength of the crosswind and gust conditions either because of his own lack of skill or because he failed to evaluate the aircraft crosswind components.

Flight Instructor Responsibilities - The flight instructor monitoring this flight should have advised the pilot of the impending severity of weather and perhaps canceled the flight or cautioned the pilot to update his weather information upon arriving at his destination. He might also have reviewed crosswind handling procedures both for landing and taxiing.

POTENTIAL PIC APPLICATION: In this case, the PIC might have served an important function in preventing this accident by providing the following:

Weather information access - weather data to make the appropriate decisions using DUAT at the airport.

Weather translated into plain language - Information translated into plain language may have given the pilot and his flight instructor a more accurate understanding of the inclement weather.

Frontal weather tutorial - a short tutorial on wind characteristics associated with cold fronts might have revealed that the day was unsuitable for flight given the experience of the pilot and the aircraft being flown.

Crosswind handling tutorial - Brief refresher course on crosswind handling including: a. referring to the handbook, and b. technique.

Examination of these accident briefs resulted in the identification of safety issues that might be resolved either through educational modules or tutorials. It is also apparent that there are many en route accident cause/factors that might be eliminated with a preflight tutorial or refresher.

There are several resources for educational modules: The FAA's "Back to Basics" Program, vendor produced videos such as ATC pilot training or AOPA rating refresher courses, and R&D, if necessary. These safety/training videos may be utilized in PIC or may be tailored through editing. Interactive tutorials may require research and development but can be accomplished if the scope of the effort is properly addressed. However, a more detailed analysis of all accidents should be conducted so that the types of modules, their cost and a phased schedule for development and implementation could be conducted.

2.1.3 FAA Weather Program Plan

Obtaining and understanding how weather may impact a flight is a requirement for every flight. The pilot must have current accurate surface observation and winds aloft data, terminal and area forecasts, pilot reports (PIREPs) as well as timely information on hazardous weather conditions such as wind shear, thunderstorms and icing (if applicable) in order to make the right decision to execute or cancel the trip. There is, however, a breakdown in the processing, dissemination and interpretation of weather data as evidenced by the number of accidents occurring each year that are related to adverse weather conditions. Between the years of 1981-1985, weather was a contributing factor in roughly 40% of all accidents, second only to pilot error at 88.7%. Technical reports along with the accident briefs showed one or more components of weather involved as a major cause/factor of the accidents. The hierarchy included the following:

1.	Unfavorable winds	43.7%
2.	Low Ceilings	23.6%
3.	Density Altitude	8.6%
4.	Wind Shifts	8.0%
5.	Carburetor Icing	6.5%
6.	Fog and Rain	5.4%
7.	Thunderstorms, Turbulence	4.2%
	Total	**100.0%**

The FAA has recognized that there are shortcomings in the delivery of timely information and also, that the pilot needs to further his ability to interpret weather information for a safer flight. The resolution of the system deficiencies is spelled out in the FAA's Aviation Weather System Plan (AWSP), a document resulting from interaction with the providers and users of the various weather products provided by the agency. Although, under revision in the form of a National Aviation Weather Program Plan (NAWPP), the 1985 document is the most current record of the objectives and goals set to improve the quality and vehicle for obtaining, processing and disseminating information to the broad spectrum of users. The timeline in the AWSP highlights projects and milestones through the year 1995 and is characterized by nine major program components.

The PIC could support and encourage use of information in all 9 areas. Each effort will be discussed briefly to provide an overview of the FAA's long term goal to improve the aviation weather system as a whole. Updated information was extracted from the 1990 FAA Plan for Research, Engineering and Development, Volume II: Project Descriptions.

1. **Surface Observation Systems (SOS):** The frequency of aviation weather observations as well as their origin must be increased both in quality and availability through the installation of a network of over 1000 Surface Observation Systems by the FAA. However, many state Departments of Transportation are also accelerating the program through sponsorship of statewide systems of Automated Weather Observation Systems (AWOS) with the near term goal of improving weather observation service to state pilots and the ultimate goal of tying into the national system. This "partnership" will accelerate the implementation plan.

Implementation benefits will include: Improved and more frequent weather data, increased number of data collection points for prediction modeling, improved forecasting accuracy, SOS displays provided to ATC and updated automatically.

Observation systems will provide real time weather at destinations where weather information has historically not been available. When these are tied into the National Weather Service and made accessible through PIC (via DUAT), a pilot can obtain a stream of weather data all along the route of flight. If for example, a pilot flying from Atlantic City, N. J. to Sussex County airport sees that visibility gradually decreases at Burlington, Solberg and Andover, (all airports along the route) he may wish to pick an alternate or wait until there is a significant improvement.

2. **Improved Winds Aloft:** Upper air data observations will be able to provide an expanded data base capable of generating accurate wind and temperature information both observed and forecast, with much improved resolution. The Next Generation Weather Radar (NEXRAD) will provide wind velocity information for altitudes above 6,000 feet throughout the contiguous United States, except over mountainous areas in the west where the lowest altitude will be 10,000 feet. Alaska, Hawaii, and the Caribbean will be included in this project plan.

Winds aloft information is critical in the preflight planning stage for fuel calculations, time en route, and route optimization. Improved forecasts will also facilitate the accuracy of weather forecasting and turbulence prediction.

3. Central Weather Service Units (CWSU): CWSUs are the focal point for professional meteorological services within the ARTCCs. Meteorological data is interpreted, analyzed and disseminated to controllers and facilities within the center's jurisdiction for: briefings, unscheduled forecasts which may impact the flow of traffic or advisory statements which describe current conditions and may augment or redefine SIGMETs. Although the installation of CWSUs have improved the relevancy and availability of weather information, communications are still impeded by the mode of operation and the speed of products generated by meteorologists.

One critical area being emphasized is the development of the Central Weather Processor for DataLink capability via Mode S and interaction with the CWSUs for real time display of weather information for controllers and pilots. This includes Real-Time Weather Processor (RWP) development, Meteorologists Weather Processor (MWP) to provide the CWSU the capability to display and manipulate these weather products.

4. Flight Service Station Automation: This program was intended to consolidate and replace the manual Flight Service Station operation. Full implementation was anticipated to meet the projected increase in user demand, improve user access to weather information and NOTAMs, simplify flight plan filing and reduce the cost of services. To date, 175 Flight Service Stations have been relocated and consolidated into 46 AFSS's. There are still 143 FSSs still operating. The FAA is committed to bringing the remaining FSSs under the consolidation program and is seeking definitive ways of assuring the user community that the FSS service will not be compromised by closing the stations. PIC has been suggested as a near term technology solution to accomplish this goal.

5. Weather Communications: The weather communications program involves the development of a Weather Communications Processor (WCP) and is intended to replace current land line communications modes to accelerate the weather information dissemination process. A WCP will be developed to interface Airborne Mode S Data Link-equipped aircraft and the desired weather products resident in the National Airspace System. En route weather information requests will be down-linked, decoded. The product will be formatted and up-linked to the cockpit. The Processor will provide the direct link between the Mode S System and NAS weather data bases, reducing the workload of specialists and controllers.

Although, communications problems and access delays to the AFSS are major complaints of pilots, the development of the Direct User Access Terminal (DUAT) will expand the availability of weather information to those users who can access computers with modems. The FAA contracted with two vendors to provide a link to the NWS data base. Additionally, these vendors offer a host of additional weather services (for a fee) such as translation of weather data into full text, route planning, airport and NAVAID data and, eventually, weather radar graphics.

6. **Improved Forecasts:** A major concern of pilots and meteorologists is the accuracy of weather information and the timeliness of these products. Pilots cite the validity of the forecast information as a rationale for ignoring inclement weather cautionary advisories. The CWSU, noted above, will assist in "nowcasting" and short term forecasting through combining real-time data sources, sophisticated computational processing, interactive display and interpretation for pilots and controllers. Part of this enhancement program also involves the development of numerical techniques, models and software for analysis and prediction of all scales of atmospheric phenomena for longer term forecasting. Statistical and synoptic weather forecast techniques will also be developed for short range forecasting and marine fog forecasting. Prediction models will be developed to simulate atmospheric and hydrologic processes to improve upper level winds and temperature forecasts for aviation and general guidance for other forecast products.

7. **Windshear Detection:** This program will focus on the educational, meteorological, technological and operational aspects of low-altitude wind shear hazards and investigate airborne wind shear detection systems. Installation of over 110 Low Level Windshear Alert Systems (LLWAS) at major airports was the initial thrust of this plan. Data and observations from these systems will assist in the mitigation of nuisance alarms caused by turbulence and Chinook wind conditions. Future applications include development of an algorithm that will detect windshear conditions within a three (3) mile radius of major airports and a wind-sensor that will perform in icing conditions. As LLWAS evolves in accuracy and reliability, an interface to NEXRAD and TDWR will be developed.

8. **Severe Weather Detection:** Specific projects are detailed in the 1990 R.E&D Plan and include:

> Terminal Doppler Weather Radar (TDWR) - Use of doppler weather radar to detect windshear and other hazardous weather conditions. Prediction of various types of hazardous weather conditions include: formation of microbursts, turbulence, tornado and storm movement.
>
> Windshear Terminal Information System Integration - Operational requirements analysis to determine airborne and ground based sensor requirements, data link capabilities and methodologies to fuse ground and air based sensor information to improve flight crew decision making. Airborne Windshear Detection and Avoidance and Airborne Windshear Advanced Technology - Development of onboard instrumentation,

techniques and displays for the provision of wind shear information to the pilot so that he/she can avoid exposure to severe low-altitude windshear.

9. **Atmospheric Characterization:** The basis of this program is to simulate atmospheric phenomenon such as icing, turbulence and lightning to gain a better understanding of its affect on aircraft operations and handling. This will facilitate certification, establishment of safe limits for aircraft operations, assist in development of more cost effective composite construction materials, digital control systems, and icing protection equipment.

In simple terms, the FAA's goal is to improve the accuracy and reliability of weather information and to communicate the data to pilots and controllers as expeditiously as possible. Evidence is anticipated in the form of reduced accident rates through better decision making. However, the program addresses primarily technological advancement for data collection and delivery and overlooks a corresponding program to make the information more understandable to the end user. As a result, the information, while timely and perhaps more reliable, may not be adequately interpreted to be meaningful to the decision maker. PIC's plain language, weather text would interpret the data improving the pilot's understanding of what current conditions exists and how a more reliable forecast will affect the flight.

In spite of the initiation of the DUAT system, (accessible to any pilot with a computer and a modem), data is still transmitted in National Weather Service symbology that must be decoded by the user. With the growing number of personal home computers and acquisition of symbolic weather data streams along with traditional prognoses and forecast charts, the need for improving pilot interpretive skills compels us to look at ways of disseminating the information so that the pilot understands the weather patterns and their affect on aircraft operations. This could be in the form of plain language weather briefings, tutorials on weather phenomena and aircraft operations provided at the "front-end" of the flight - during preflight planning on the ground.

2.1.4 Inquiry of State Aviation Officials

The FAA's Weather Communications and Observation program components are supported and augmented by aviation weather programs sponsored by state aviation organizations, departments and local municipalities.

The purpose of this task was to determine how state aviation agencies are involved in disseminating weather data to its user community. This involvement could be in the form of: promotion of flight and weather information services on the market, provision of flight and weather information services, installation of computer terminals so that airports or FBO's could subscribe to services, installation of hardware and subscription to services, installation of AWOS equipment with computer access for pilots or no support at all. Because the concept of PIC relies on a network of computers and peripherals located at airport terminals or fixed base operators (FBOs) there appeared to be great benefits in terms of reducing acquisition costs and expanding the quantity and quality of information by merging the two agency programs. Therefore, the extent of states' programs needed to be assessed in order to determine how and if the FAA might dovetail PIC into the overall system.

An informal survey was conducted of the state aviation directors at the March 1990 NASAO conference in Washington, DC. During an afternoon session, state aviation directors and officials were queried on their individual programs or plans for weather information systems. Those directors not responding at the conference were mailed a copy of the survey questions. The survey looked at the following major points:

1. Existing systems, plans for or lack of plans for weather information systems program (WISP).

2. If they already had a WISP in progress, how many computers have been installed, and how many additional computers will be installed?

3. The types of computers and peripherals that have been installed.

4. How are the systems funded and what is funded, e.g. hardware and/or subscription?

5. What vendor provided the weather and/or flight planning service?

Survey results were tabulated and summarized in Table 2.0 and included the states' program status, anticipated date of completion, hardware, and software standards. In total, 42 of 50 states (84%) provided information on their state programs. Table 2.0 shows that 50% of the states have at least planned for or would like to implement weather related programs in their states. Of the 17 states that have no plans for a WISP, some indicated that legislative action is needed for the aeronautics agencies to be able to include the funding of computers and/or subscription services in their overall airport development grant-in-aid programs. Finally, the common denominator in operating systems was DOS. All states responding indicated they would install or currently utilize IBM or IBM compatible computer equipment.

In considering the number of systems installed (226) and the additional systems planned (256), the opportunity for PIC to be operational in the short term (3-5 years) is great. However, the survey did not provide two key elements to implementation of PIC: First, identification of standard criteria for site selection; and second, total state system needs assessment which considers planned or existing programs as well as an estimate of automation needs for states not planning on computer systems.

Although the data received was informative, it is recommended that a total nationwide systems needs assessment should be conducted along with the development of site selection criteria. The number of units or computer stations required, system implementation costs for hardware, and funding requirements would be determined over near, mid, and long term planning horizons.

Table 2 0 NASAO SURVEY DATA

Questn	1-Type	Plan		2	Comp.	Instld		3	Access		4	State	Funds	5	Type	Comp		6		Hrdw	Prvd			
State	Provide	Plan to	No	# Instld	# Oper'l	# Plnd	Date	Phone	800 #	FBO	FBO	Cmptrs	Subscp	Mac	IBM	IBM	FBO	Mdm	Prtr	Color	CD	Video	Video	Hard
		Provide	Pln'd				Compltd			Trml	cptr	only	Only			Cmpt'l	Choice			Mntr	ROM	Tape	Disk	Disk
AK			√																					
AZ		√																						
AR			√						√	√														
CA		√				50		√	√			√				√		√	√	√				√
CO		√																						
FL			√																					
GA			√					√								√		√	√	√		√	√	√
HA			√					√																
ID			√																					
IL		√																						
IA		√		3		50	1995		√			√			√			√	√	√				
LA		√						√																
KA		√							√	√														
ME			√						√															
MD			√																					
MI		√									√					√		√	√	√				√
MN	√	Δ		78	78	6	1990			√	√					√		√	√	√				√
MS			√																					
MO		√																						
MT		√				1		√	√							√			√	√				
Nb	√			17	17	7		√		√			√				PanAm	√	√	√				
Nv		√														√								
NH			√						√															
NJ		√				20										√		√	√	√				√
NM	√	√		0	0	4		√									AWOS	√	√	√				
NY			√														√							
NC			√																					
ND	√			8	8	8 to 10	1993				√					√	PanAm	√	√	√				
OH		√									√					√								
OK			√	4	4	u/k		√		√	√						√							
OR		√							√															
PA	√			40	40	20	1991	√		√	√					√		√	√	√				
RI			√					√	√															
SC			√						√															
SD		√						√	√							√								
TN			√					√	√															
TX			√																					
VA	√			14		13	1991		√	√	√					√		√	√					
VT		√						√							√	√								
WV		√																						
WA	√			6	6	10	1991	√		√	√	√				√		√	√	√				√
WI	√			56	56	75	1991	√	√	√	√					√		√	√	√				√
Totals	8	17	17	226	209	256		15	14	9	8	3	1		2	16		13	14	13		1	1	5

Table 2.0 NASAO SURVEY DATA

	7	Fund	Source									8	Wx	Svc	Vendor					
Other	Subscr			Daily	Operatn		Maint.			Other		PanAm	AccuWx	WSI	Kavris	DUAT	Glbal	EMI	Unval	Other
Ident	FBO	State	Advrts	FBO	State	Advrts	FBO	State	Advrts	Specify								Cmpsrv	WX	Spcfy
	√			√			√													
					√			√												√
	√	√		√																
		√			√			√							√					
					√							√								
	√	√					√	√				√								
	√			√			√									√				
							√	√												Paid Wx Obsvr
	√			√																
		√			√			√				√								
TBD	√			√			√					√								
				√			√													
		√			√			√				√								
														√	√					In House Only
	√		√	√		√	√		√			√								
	√						√					√								
Satel.		√			√			√				√								
	8	6	1	7	6	1	8	7	1			8		1	2	1				

2.2 LISTENING SESSIONS

In order to determine how the user community felt about the concept of a Pilot Information Center, the contractor, in coordination with FAA-AOV staff, was to hold four listening sessions around the country. These listening sessions were originally designed to ask pertinent questions about preflight planning, awareness of publications and materials for assisting the pilot in this "phase of the flight" and to receive input as to what types of information would enhance their ability to make proper interpretations on weather, operating in and around controlled airspace. Pilots were also to be asked for input on the types of information desired to help them better understand aircraft and pilot performance as well as limitations.

2.2.1 Oshkosh! The First Listening Session

The first listening session was held at the Experimental Aircraft Association annual air show at Oshkosh Wisconsin on August 1st at 1:30 pm. A small audience was in attendance and changed in size from 20 at the onset of the session increasing to approximately 35 by the end of the briefing. Using slides and overheads, the concept was presented to the audience with AAC asking the pilots to respond to a set of predetermined questions. The sessions was broken up into two phases; the first few minutes were devoted to describing PIC and its proposed utility in improving preflight planning. The second phase was comprised of a series of questions and key words which were expected to elicit responses from the audience on various subjects. The objective was to determine what the deficiencies were in the average pilot's planning methodology so that tutorials and educational information could be created to address these problems. These charts and questions included the following:

a. Introduction Slide: PIC.

b. PIC: A Tool to Improve the Preflight Planning Process - Description of how PIC is expected to help pilots expand and update their flying knowledge.

c. What and Where - What it will consist of and where it is anticipated to be sited.

d. Connections - Conceptual diagram of the system.

e. Goals and Objectives of PIC.

f. What types of information will PIC provide? List of guidelines, graphics, regulations and tutorials to be considered in developing the PIC.

g. How will we determine what information should be included? Overview of use of existing information and programs which will be evaluated in developing the encyclopedic concept.

h. Announcement of ASRS briefing being held on August 2nd.

i. The pilot is our best resource - Explanation of why listening sessions are being used and the effort to get user input.

j. Listening Sessions Map - Depiction of where listening sessions would be held.

k. How many miles from your home airport do you typically fly? Question to determine: average stage length of flight, if intermediate stops are attempted and is weather or flight information updated during the stop.

l. Think back to some your of recent cross country flights. Question queried on ability to reach Flight Service, thoroughness of briefing, request for and receipt of all applicable NOTAMs, PIREPs and alternate route weather information.

m. Filing a VFR flight Plan: Question to determine if flight plan filing was a routine part of cross country flight, what, if any, was typical rationale for not filing and under what circumstances would a pilot fly without obtaining briefing.

n. VFR Preflight Planning Accident Pie Chart: Graphic display of most frequent cause factors involved in accidents.

o. What resources do you use to keep abreast of flying knowledge? Question to identify the types of documents pilots use to update their knowledge of changes in the airport and airspace system.

p. How many subscribe to the Airman's Information Manual? Question to determine if the AIM is common periodical read and subscribed to by individual pilots or if they rely on local FBO for maintaining current copy.

q. Series of questions on regulations, how pilots learn about changes, are they reviewed frequently, do they comment on proposed changes or know how to formally comment. How should they be displayed? Should the regulations be consolidated for quick reference? Should they be highlighted within an FAR lexicon and/or with access to expanded explanation as to its revision?

r. Series of questions regarding controlled airspace: Whether or not pilots routinely transit TCAs, avoid TCAs and if they felt tailored TCA, TRSA and ARSA briefings would be useful and what types of information should be included in each briefing.

s. Do you know how often navigation charts are updated? How can you get the information?

t. How should information on special use airspace be displayed? Question to determine if and how military or special use airspace activity should be provided.

u. What other types of information would help you make better preflight planning decisions?

v. Final Slide: Whom to contact to provide additional input.

2.2.2 Debriefing: Improvements Necessary to Make Listening Sessions More Meaningful and a Better Resource for Information.

In spite of the large number of pilots registered at Oshkosh, the session was poorly attended by the flying community. Competing for the attention of EAA attendees was the good weather, other forums, and a demonstration take-off and flyby of the SR-71, Blackbird.

As questions were asked, many pilots appeared to be reluctant to respond requiring continuous prompting by the contractor and the FAA. Rather than a free flow of discussion on PIC issues, the contractor chose pilots from the audience to provide their perspectives. Overall, the discussion, though limited, validated the assumptions made by the study team. Highlights of the responses are as follows:

a. Air Traffic Control: If any subject provoked discussion it was airspace. Pilots felt that more emphasis should be placed on recognizable "fixes" in reporting, charting and on tailored PIC briefings. It is generally perceived that the difficulty navigating around and through controlled airspace is due to the lack of information concerning boundaries, reporting points, landmarks, and preferred ingress/egress.

Two major requirements requested by pilots:

1. Updated information on TCA's, ARSA's and TRSA's should be easily accessible.

2. Preferred routes and reporting points are essential for safe navigation through controlled airspace.

b. Improved Pilot Report (PIREPs) Acquisition/Dissemination: Pilots rely heavily on the reports of other pilots who are en route or have completed their flights. This type of information gives other pilots confidence in their decision to go or no go and efforts to increase the number of pilot reports should be made through PIC.

c. En route Frequencies: Pilots frequently have difficulty obtaining weather information en route. Communications with FSS was cited as the major problem in receiving not only weather information but in opening and closing flight plans when airborne.

d. Filing Flight Plans: There are two problems with filing flight plans, those that want to open flight plans have difficulty once airborne with frequency congestion resulting in an inability to raise the FSS over the radio. Many pilots fly for recreation and found the process of filing-opening-closing a hassle.

e. Military or Special Use Airspace: Many pilots wishing to transit MOAs or restricted areas (with permission) would like to know what the safe operating altitudes are upon entering the airspace. They feel that too often they encounter military aircraft on maneuvers at their altitude. To enhance safety and assure proper separation, the military control unit or RAPCON for that area might recommend or assign an altitude to the transiting GA aircraft.

f. Reference Material: Nearly everyone surveyed reads some form of flying periodical but few subscribe to the AIM. Subscription to J-Aid through Jeppesen was suggested as a source for regulatory information and updated airport data. Pilots were attuned to the need for NOTAMs in planning their flight, however, few knew what the different classes of NOTAMs meant.

2.2.3 DISCONTINUATION OF LISTENING SESSIONS

The results of the first listening session lead to a restrategizing of the format from general inquiry to that of presenting the scope and benefits of PIC followed by a question and answer period to get feedback. Assuming that it is easier for an audience to critique a given scenario than to ask them to create it, the nature of the briefing was changed. New slides were developed to fit the new scope of the PIC presentation.

Plans for making presentations were continued, coordinating with Accident Prevention Specialists in Regional offices including: California, Southern Region, and Eastern Region. Dates for Safety Seminars were obtained and agenda time was allocated for presenting the PIC project in its new format. The second of these sessions was to be held at Andrews Air Force Base during a General Aviation Fly-in and Safety Seminar to be held at the end of August, 1989. Due to the inability of base officials to program FAA staff into the agenda and the lack of a suitable conference room, this session was canceled.

Future sessions were postponed, however, as PIC took on new dimensions of importance in its potential for helping to resolving the Flight Service Station access problems encountered with the automation of these facilities.

Listening sessions can provide valuable user input on the operational characteristics and deficiencies of today's airspace and airport system. Pilots are willing to discuss problems they have encountered and offer suggestions on improving or resolving them. A prototype PIC should be demonstrated, tested and refined in coordination with NASAO so that the system can be advanced and become operational.

2.3 PIC SPECIFICATIONS DEVELOPMENT

Conceptually, PIC was envisioned to act as a "clearing house" of information, combining into one source, all resource material from the FAA as well as tutorials on a variety of pertinent preflight planning subjects. However, critical to PIC was the means of delivering the information so that not only could the DUAT system be fully utilized but an extensive amount of information could be stored, updated and presented in the most "user friendly" mode possible. Hardware had to be identified along with means of transmitting and receiving information, and software capable of special programming to provide tutorials in the form of interactive modules was researched.

An outline providing a generic PIC "system" was created along with anticipated unit costs, and tasks to accomplish nationwide implementation of PIC. The following is the outline presented to AOV regarding the Educational and hardware specifications and costs. Assessment of system needs was also recommended so that budgeting for both R&D, hardware and installation could be programmed.

The Pilot information Center is a comprehensive automated system designed to improve the safety of flight through the preflight planning process. In the near term, PIC will encompass DUAT and FSS functions, weather graphics, airport/facilities directories and TCA charts and will be accessible at FBOs or by home computer. In the long term, PIC will be expanded to provide weather translated into plain English, route/weather overlays, terminal airspace video briefings, procedures guidelines, operational information, tutorials on interpreting weather, regulatory and advisory information.

The following is a basic outline on PIC along with steps and considerations in implementing the PIC system.

A. PIC System Definition and Requirements

1. Flight Planning Based on Nature of Flight Activity: Allows pilot/inquirer to retrieve information based on type of flight activity: Local, Selected Route, Region, Cross Country, Other (Review of information or close of flight plan).

2. Augmentation and Consolidation of Existing Programs. Integration and expansion of currently existing automated FAA flight planning programs with innovative video and information materials.

a. DUAT - Incorporation of DUAT into near term PIC to provide automated weather service and basic flight plan filing and closing activities. Includes current system of advising on NOTAMS, PIREPS and Military airspace.

b. Weather Services - Expansion of current and DUAT weather services to improve interpretation of elements of weather (e.g., fronts, temperature gradients, barometric pressure differential, etc.) along the route of flight.

(1) Plain English Weather - Translation of weather symbology from data stream to full text and numbers in order to assist pilot in obtaining "big picture" of weather events.

(2) Weather Charts - Standard series of NWS weather charts that can be enlarged and cropped for "selected" region.

(3) Weather Graphics - Radar summary of weather activity for given region.

(4) Selected Route Weather Overlays - Overlay of selected route onto weather radar summary for selected region to assist pilot in choosing alternate route or destination.

(5) Improved Pilot Reporting System (PIREP) - Improvement in PIREP reporting and dissemination with two point effort. Accessibility through PIC. Improvement plan for PIREP acquisition & dissemination:

(a) Increased emphasis on AFSS inquiry process to obtain and record pilot experience with route and terminal weather.

(b) Increased emphasis on using Flight Watch for reporting, recording and disseminating en route weather conditions.

(6) Airspace Terminal Area and Military Airspace Information to be accessible through PIC for viewing and planning purposes prior to flight. To include:

(a) Currently available charts
(b) Navaids and frequencies
(c) Status of military activity
(d) Requests for transition through military airspace

(7) NOTAMS - Consolidate and Disseminate all NOTAMS which pertain to a "selected" route. May require software development to key in NOTAMS as a function of its relationship to station identifiers.

c. General Information - "Library" of information basic to preflight planning including currently under publication with the Superintendent of Documents, National Technical Information Service:

(1) Airport Facilities Directory

(2) Airman's Information Manual

(3) FARs Part 61 and 91

(4) Augmentation of Existing Programs through Incorporation of newly developed programs. Accessibility of information that will assist the pilot in understanding weather, operations and airspace as well as regulatory and advisory changes that will facilitate good pilot decision making.

(a) PIREP Inquiry Function - Closing of a flight plan will instruct the PIC to query the pilot on the weather conditions of a particular flight. Information will be "sent" to host for widespread dissemination.

(b) Real Time Weather Data Acquisition - Aircraft installed weather sensor instrumentation with data link to improve reporting of actual weather conditions at altitude.

(c) Airspace - Expansion of terminal airspace information to include:

[1] Procedures for entering, departing and operating in controlled or military airspace.
[2] Aerial video providing terminal specific briefing on entering TCA, TRSA or ARSA.
[3] Aerial graphic with terminal airspace boundaries, reporting points highlighted.
[4] Terminal area graphic depicting routine traffic flows around high density airports.

(d) Weather Tutorials - Tutorials focusing on interpretation of weather patterns, trend analysis both in short and long range outlooks. Guidelines on obtaining the appropriate types of information to make good judgment on flight in light of existing and forecast conditions.

(e) Operational Guidelines - Tutorials and guidelines for operating aircraft under various flight conditions, for example: high and gusty winds, high density altitude, recovering from inadvertent IFR penetration, proper leaning, and circumnavigating thunderstorms.

(f) Navigation Computer - Keypad navigation computer function for calculating:

[1] Weight and balance
[2] Course
[3] Fuel consumption
[4] Time En route

(g) General Information - Information which will assist the pilot in the decision making process or in becoming familiar with recent changes in the aviation system.

B. Hardware/Software/Resources Requirements

1. Generic Hardware Specification

a. Personal Computer or Terminal
b. CD/ROM
c. Modem
d. Color Monitor
e. Mouse
f. Keyboard
g. Satellite Receiver

2. Software and Video Requirements

a. Graphical Interface
b. Telecommunications
c. Weather graphics
d. Flight planning
e. Data Base Management
f. Systems Integration
g. Other

3. Information Resources

a. DUAT
b. NOAA
c. AIM
d. Advisory Circulars
e. Regulations
f. National Flight Data Center
g. Air Traffic Handbooks
h. National Weather Service
i. Military Air Operations

4. Communications Options

a. Land lines
b. Dedicated telephone line
c. Microwave
d. Satellite

5. Maintenance/Technical Support

a. Technical Support
b. Repair Maintenance
c. Alternatives

(1) In-house Maintenance/Technical Support
(2) Contract Maintenance/Technical Support

C. PIC Network Potential

1. **Immediate Volume - Prototype plus 61 units**
2. **Mid-Term Volume - 2965 (number of 1986 NPIAS airports)**
3. **Long Term PIC Network Volume - 3409 (1995 NPIAS projections)**
4. System Needs Assessment

a. Criteria development

(1) Establish Siting Criteria
(2) Establish Phased Installation Criteria

b. Needs assessment

(1) Total System Needs
(2) Phased System Needs

D. Funding

1. Resources for unit funding

a. FAA F&E
b. States-Demonstration or state sponsor program
c. Airport Sponsor - matching grant (AIP) program
d. Private Industry

(1) FBO
(2) Corporation

2. Resources for operational funding

a. FAA
b. Joint FAA/Sponsor
c. FBO
d. Fee for service
e. "900" Fee Number access
f. Advertising Revenue

E. Implementation

1. Hardware/Software Specifications Development

a. Hardware:

(1) System Considerations

(a) PC/DOS
(b) Apple MacIntosh
(c) Other

(2) Suite Design

b. Software and Information Resource Analysis and Specification

(1) Resource assessment

(a) Existing software, data base and information
(b) Graphical Interface
(c) R&D software, data base and information
(d) Video R&D
(e) Tutorials

(2) Resource specification

(a) Existing Public domain
(b) Existing Industry Market
(c) R&D project development
(d) Weather data collection networking e.g. Federal & State agency weather data collection incorporated into NWS system (AWOS, FHWA, EPA, DOI, NRC, etc.)

2. Siting and installation alternatives

a. Location

(1) Sponsor terminal
(2) FBO

b. Base Suite Cost Assessment

This outline provides a preliminary and superficial specification of PIC, its components and steps to be taken to carry out the concept PIC program. A detailed systems specification should be performed so that PIC can be further refined. With the potential for marrying both the state and federal programs, implementation of PIC could be accelerated.

3.0 RECOMMENDATIONS AND CONCLUSIONS

Each task performed resulted in a conclusion about further work that should be conducted. A summary of these recommendations follows:

3.1. A more detailed assessment of the types of modules, their cost and a phased schedule for development and implementation should be conducted considering a more extensive review of accident cause factors. A generic definition of information categories should reflect how a PIC can excel beyond other information dissemination mechanisms available to pilots (e.g., providing real time or near real time safety alerts, warnings, aircraft performance analysis, PIREPs, etc).

3.2. With the growing number of home computers and employment of symbolic weather data streams, prognosis and forecast charts, the need for improving pilot interpretive skills becomes more important. We are compelled to look at ways of disseminating the information so that the pilot understands the weather patterns and their affect on aircraft operations.

3.3. A nationwide systems needs assessment should be conducted along with the development of site selection criteria. The needs assessment would identify the number of work stations required, whether the hardware would be acquired by the states or the FAA, and where they would be installed. A PIC Implementation Plan would result from the study to determine how the installation would be phased and the funding required. Critical to the needs assessment would be the development of siting criteria to prioritize the installation of work stations.

3.4. A prototype PIC should be developed and taken into the user community for demonstration, testing and refinement so that the system can be advanced and become operational.

3.5. An analysis of the approaches to setting automated information delivery system standards should be conducted. This investigation should take into account the fact that such systems are evolving rapidly and would result in a generic system specification standard.

APPENDIX A: ACRONYMS

AAC	Advanced Aviation Concepts
AFSS	automated flight service station
AIAA	Aerospace Industries Association of America
AIM	Airman's Information Manual
AOPA	Aircraft Owners and Pilots Association
AOV	FAA Office of Safety Information and Promotion
ARSA	airport radar service area
ARTCC	air route traffic control center
ATC	air traffic control
AWSP	Aviation Weather System Plan
CD/ROM	compact disc/read only memory
CWSU	central weather service unit
DOI	Department of the Interior
DOS	disc operating system
DUAT	direct user access terminal
EAA	Experimental Aircraft Association
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
FBO	fixed base operator
FHWA	Federal Highway Administration

FSS	flight service station
GA	general aviation
GPO	Government Printing Office
IAA	International Aerospace Abstracts
IAC	Information Access Company
IFR	instrument flight rules
IMC	instrument meteorological conditions
kts	knots
LLWAS	low level windshear alert system
MCC	mesoscale convective complex
MOA	military operations area
MWP	meteorologists weather processor
NAS	National Airspace System
NASAO	National Association of State Aviation Officials
NAVAID	navigational aid
NAWPP	National Aviation Weather Program Plan
NEXRAD	Next Generation Weather Radar
NOAA	National Oceanic and Atmospheric Administration
NOTAM	notice to airmen
NPIAS	National Plan of Integrated Airport Systems
NTIS	National Technical Information Center
NTSB	National Transportation Safety Board

NWS	National Weather Service
PC	personal computer
PIC	pilot information center
PIREP	pilot report
RAPCON	radar approach control
R & D	research and development
R,E&D	research, engineering, and development
RWP	real-time weather processor
SIGMET	significant meteorological information
SOS	surface observation system
SPIFR	single pilot IFR
STAR	Scientific and Technical Aerospace Reports
TCA	terminal control area
TDWR	terminal doppler weather radar
TRSA	terminal radar service area
VFR	visual flight rules
WCP	weather communications processor
WISP	weather information systems program